

67415
Noritic Anorthosite
175 grams



Figure 1: Photo of White Breccia Boulders on rim of North Ray Crater where 67415, 67455 and 67475 were collected. Boulder is about 1 meter high. AS16-106-27326.

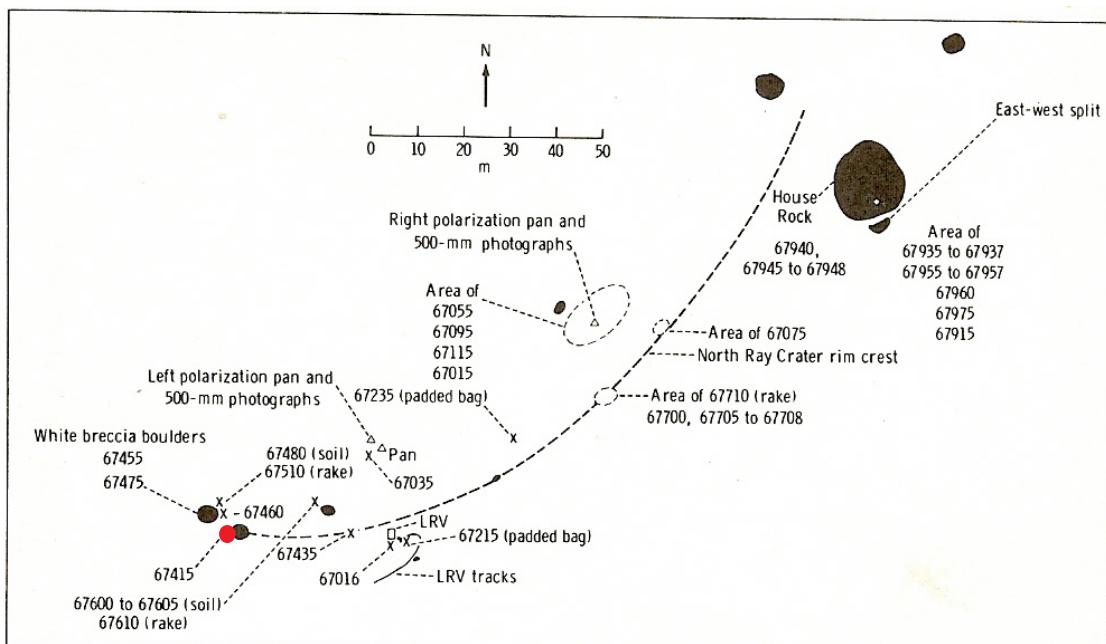


Figure 2: Map of south rim of North Ray Crater.

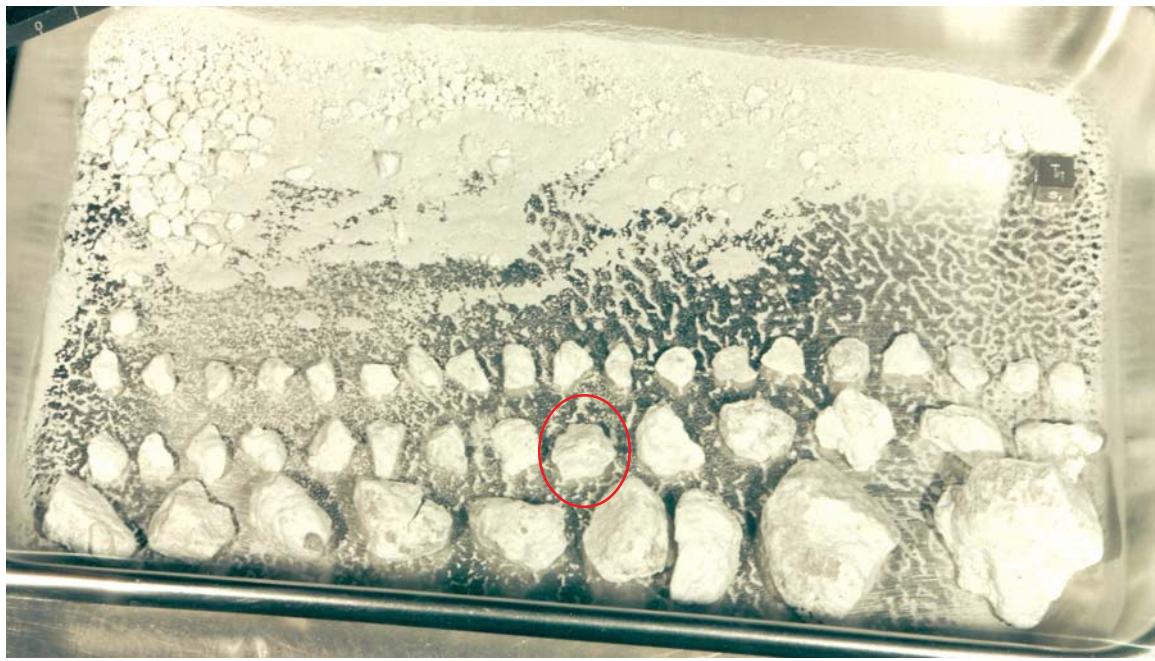


Figure 3: Photo of 67415 showing that it is very friable. S72-39037. Split ,1 (circled) was used to make thin sections.

Introduction

67415 is very friable. It was collected among the White Breccia boulders on the rim of North Ray Crater, Apollo 16 (figure 1), but does not seem to be representative of them. However, detailed petrographic description is lacking.

Petrography

There has been no reliable petrographic description of 67415. Stoffler et al. (1981) termed it a cataclastic noritic anorthosite. Cushing et al. (1999) described the texture as poikilitic. Ryder and Norman (1980) found that it was composed predominantly of angular grains of plagioclase with lesser amounts of mafic minerals (mostly orthopyroxene), granoblastic lithic fragments, minor metal – some rust, troilite, ilmenite and very rare symplectite. They pictured one lithic fragment (figure 4).

According to Lindstrom and Lindstrom (1986), 67415 is a lightly-shocked, granulitic breccia with a cataclastic matrix. The rock is extremely friable and has disintegrated into a fine powder and a few large chunks which continue to disintegrate (figure 1). Mineral proportions in relict lithic fragments are variable, but all have 70-90% plagioclase. Mafic minerals are roughly shown in figure 7.



Figure 4: Small clast in thin section 67415,14 (from Ryder and Norman 1980). See also figures 10 and 11.

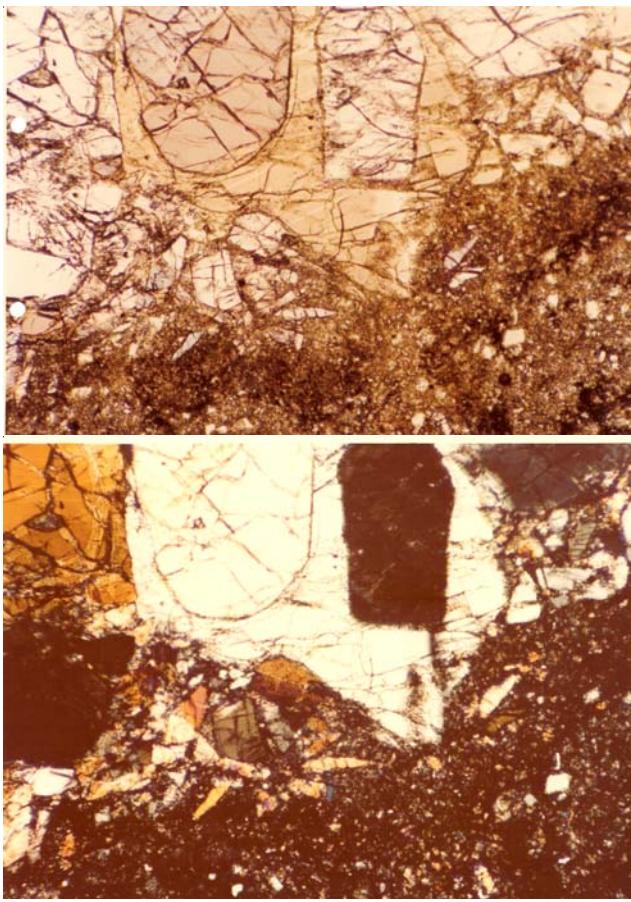


Figure 5: Thin section photomicrographs of thin section 67415, 14. Top is plane-polarized, while bottom is crossed-polarized light. Field of view is 1.4 mm. S79-27677 and 27678.

Pyroxene: Cushing et al. (1999) present the only pyroxene analyses

Chemistry

Wanke et al. (1976, 1977), Lindstrom et al. (1977) and Hertogen et al. (1977) initially analyzed 67415 (table). Superior isotope dilution data by Wiesmann and Hubbard (1976) seems to match (figure 8). Lindstrom and Lindstrom (1986) analyzed additional separates (table).

Moore and Lewis (1976) and Cripe and Moore (1975) reported C = 13 ppm and N = 99 ppm.

Radiogenic age dating

Marvin et al. (1986) reported an Ar/Ar plateau age for 67415 of 3.96 ± 0.04 b.y. (figure 9).

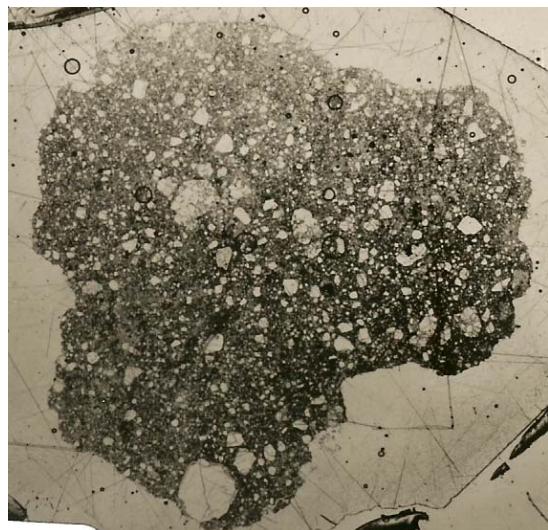


Figure 6: Thin section prepared from 67415, 1.

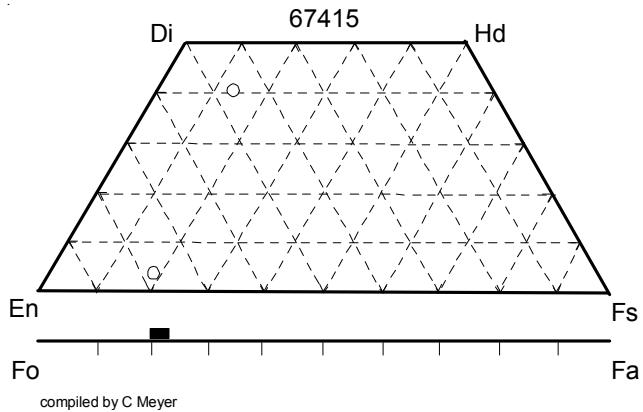


Figure 7: Mineral compositions crudely plotted from table in Lindstrom and Lindstrom (1986).

Processing

There are 18 thin sections of 67415, yet no decent description. The powder should be sieved, and mineral separates prepared for analysis as grain mounts.

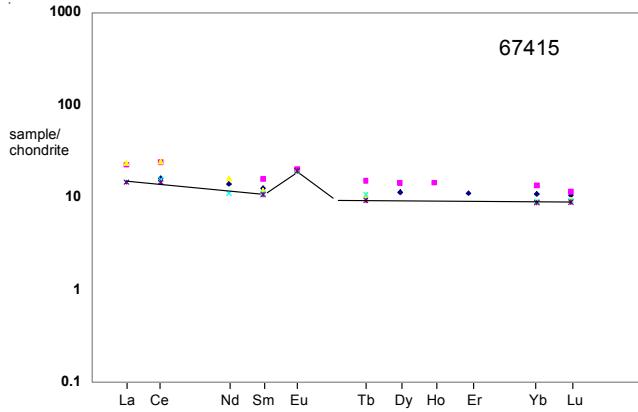


Figure 8: Normalized rare-earth-element diagram for 67415 (data from table).

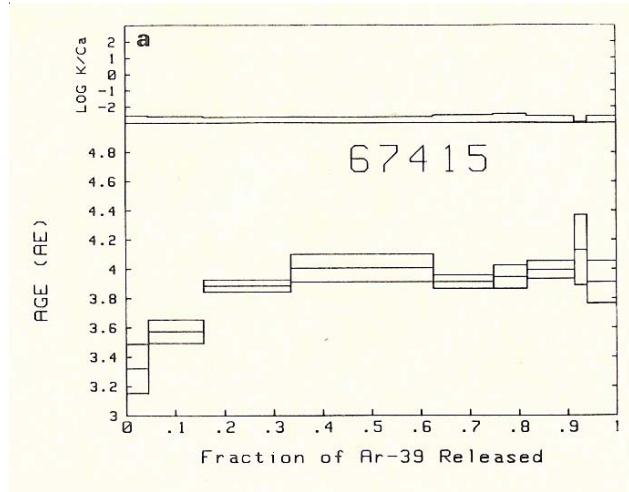


Figure 9: An attempt to measure the age of 67415 was made by Marvin et al. (1986).

Summary of Age Data for 67415

Ar/Ar

Marvin et al. 1986 3.96 ± 0.04 b.y

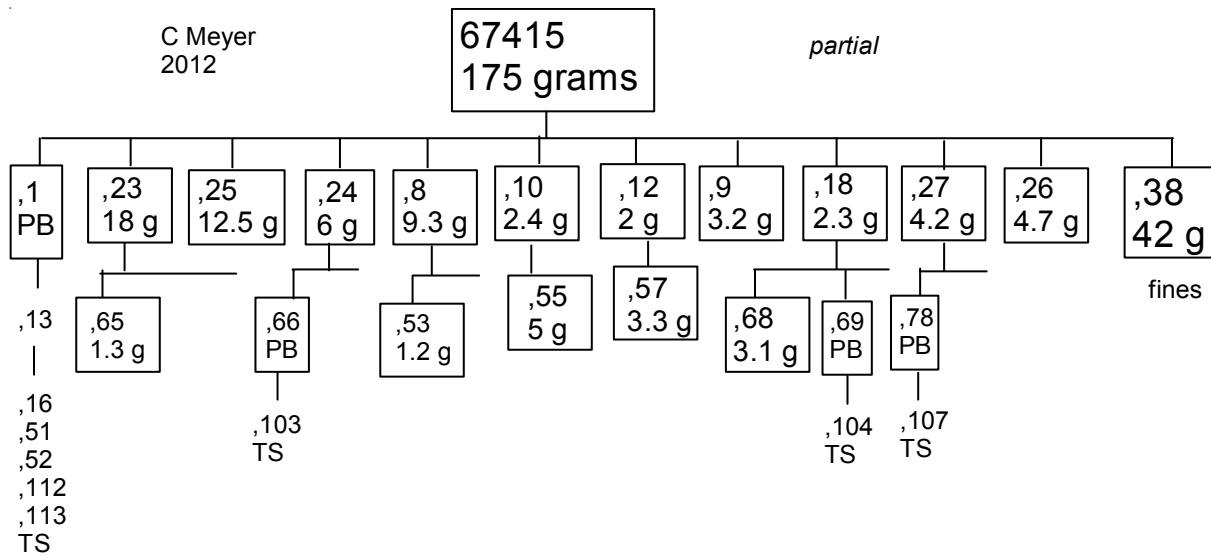


Figure 10: Photos of thin section 67415,16. 2 mm across

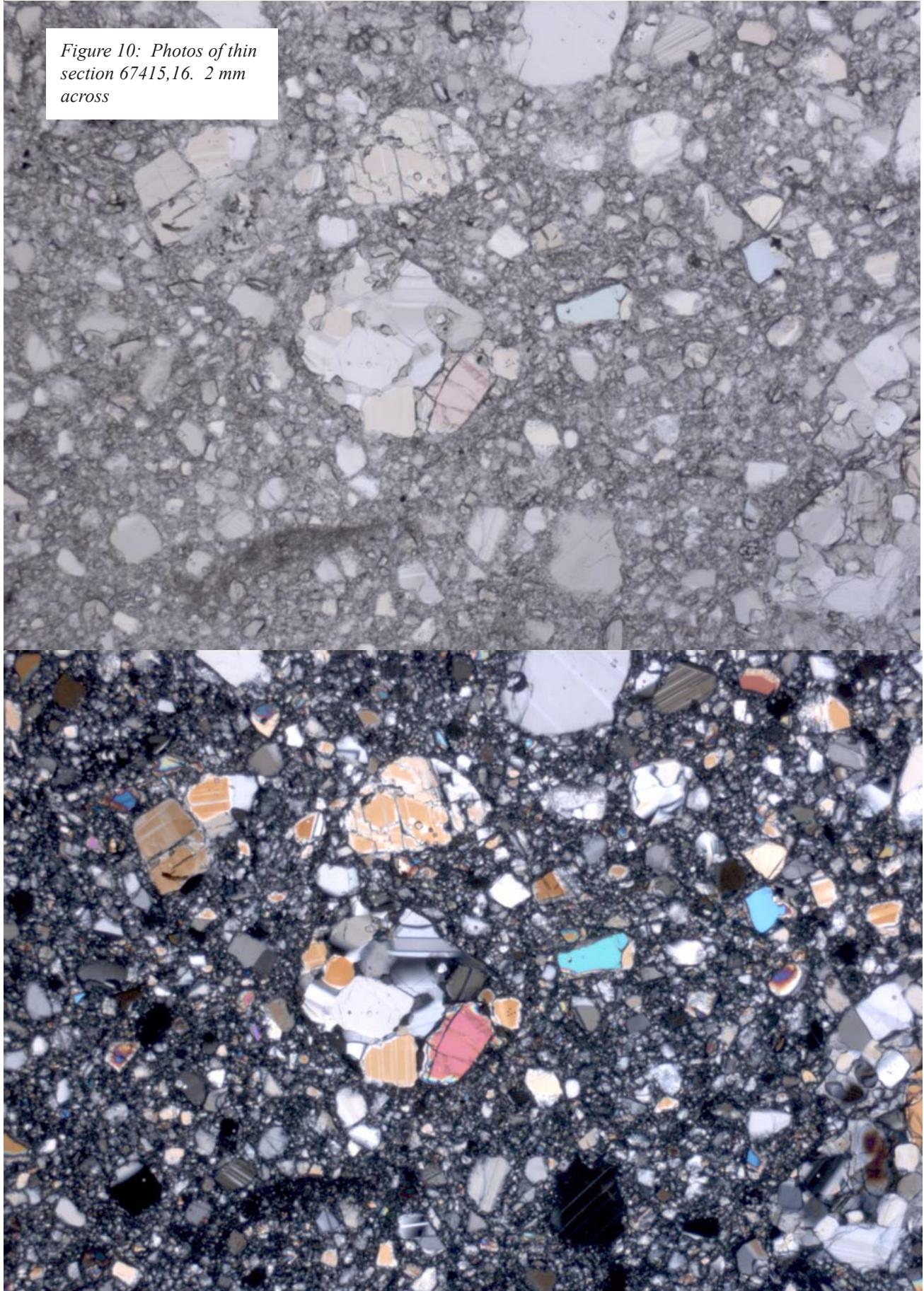


Figure 11: Photos of thin section 67415,113. 2 mm across

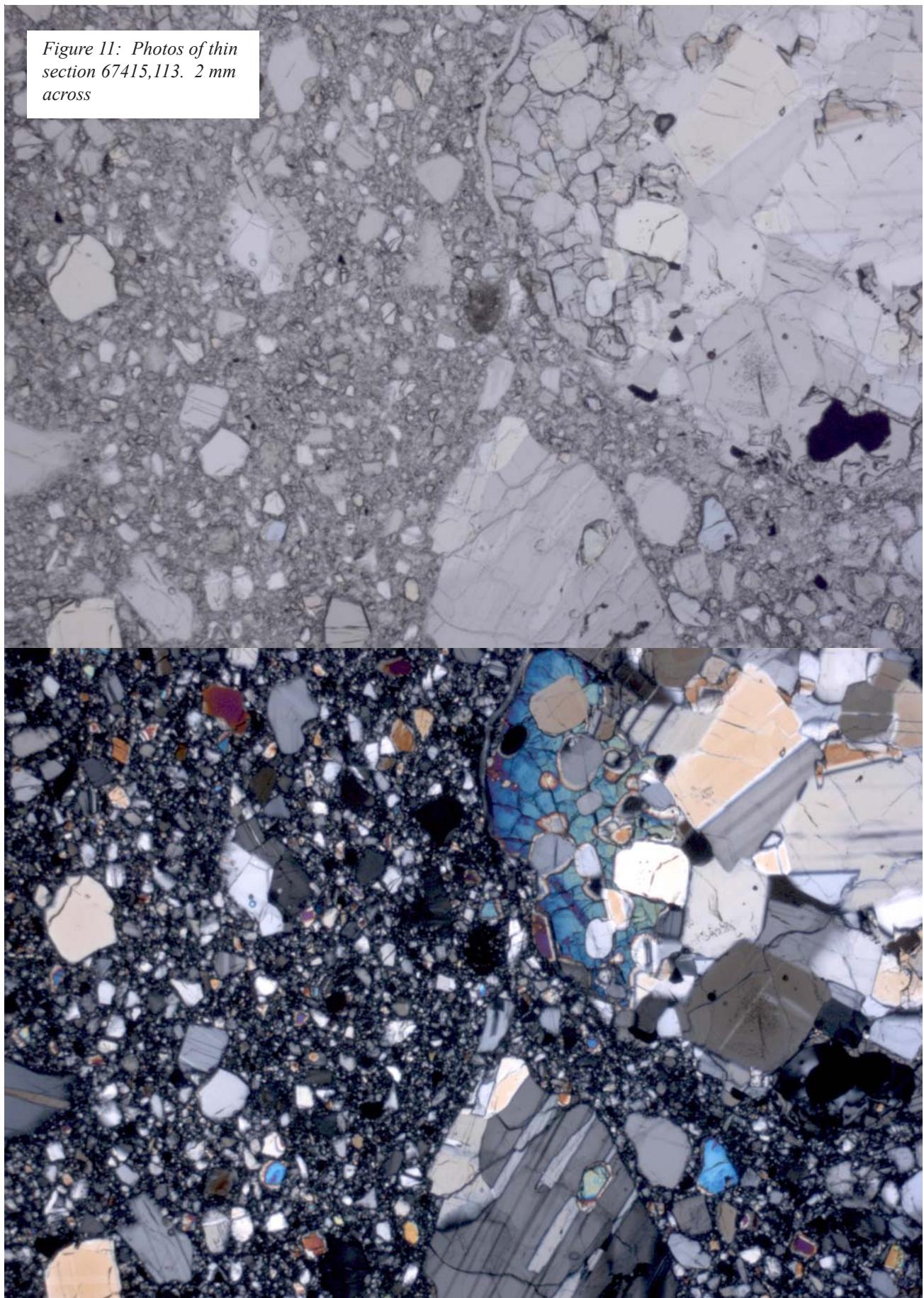


Table 1. Chemical composition of 67415.

reference	Lindstrom77	Hertogen77	Wanke 76	Lindstrom 86	Lindstrom81	Wiesmann76
weight				Lindstrom86		
SiO ₂ %	44.6	(a)	45.6	(a)		
TiO ₂	0.32	(a)	0.43	(a) 0.42	(d) 0.41	(d)
Al ₂ O ₃	26.04	(a)	24.7	(a) 27	(d) 26.6	(d)
FeO	4.64	(a)	5.12	(a) 4.6	4.75	(d) 4.76
MnO	0.06	(a)	0.069	(a)		
MgO	7.77	(a)	7.92	(a) 7.5	(d) 8.2	(d)
CaO	15.05	(a)	14.8	(a) 14.6	14.4	(d) 14.9
Na ₂ O	0.52	(a)	0.53	(a) 0.49	0.48	(d) 0.49
K ₂ O	0.04	(b)	0.06	(a)		0.041 (b)
P ₂ O ₅	0.03	(a)	0.03	(a)		
S %						
<i>sum</i>						
Sc ppm			8.3	(a) 6.13	6.19	(d) 6.21
V						
Cr			830	(a) 707	688	(d) 717
Co				12.1 (a) 14.9	14.5	(d) 37.9
Ni		59	(c) 120	(a) 164	162	(d) 480
Cu						
Zn			5.8	(c)		
Ga						
Ge ppb			11.2	(c)		
As						
Se			1.9	(c)		
Rb	0.964	(b) 0.64	(c)			
Sr	177	(b)		158 (a) 183	187	(d) 230
Y			25	(a)		(d) 176
Zr			60	(a) 55		67
Nb			3	(a)		(b)
Mo						
Ru						
Rh						
Pd ppb			2.85	(c)		
Ag ppb			0.46	(c)		
Cd ppb			1.93	(c)		
In ppb			1.38	(c)		
Sn ppb						
Sb ppb			0.46	(c)		
Te ppb			9.9	(c)		
Cs ppm			0.04	(c) 0.077	(a) 0.065	0.056 (d)
Ba	61.2	(b)		85 (a) 63	60	(d) 61
La				5.27 (a) 5.56	3.46	(d) 3.42
Ce	9.62	(b)		14.4 (a) 14.7	9.35	(d) 8.83
Pr						(d) 10.9
Nd	6.23	(b)			7.2 5	(d) 6.77
Sm	1.84	(b)		2.33 (a) 1.73	1.62	(d) 1.57
Eu	1.11	(b)		1.13 (a) 1.075	1.055	(d) 1.08
Gd						2.43
Tb				0.55 (a) 0.385	0.389	(d) 0.339
Dy	2.75	(b)		3.47 (a)		2.8
Ho				0.8 (a)		
Er	1.77	(b)				1.78
Tm						(b)
Yb	1.75	(b)		2.2 (a) 1.46	1.45	(d) 1.43
Lu	0.255	(b)		0.28 (a) 0.228	0.223	(d) 0.218
Hf				1.96 (a) 1.7	1.33	(d) 1.26
Ta				0.35 (a) 0.406	0.229	(d) 0.224
W ppb						
Re ppb			0.187 (c)			
Os ppb			2.18 (c)			
Ir ppb			2.04 (c) 4.1	(a) 4	3.6	(d)
Pt ppb						
Au ppb			1.02 (c)			
Th ppm				1.07 (a) 1.11	0.77	(d) 0.79
U ppm			0.211 (c)	0.19	0.23	(d) 0.23

technique: (a) mixed, (b) IDMS, (c) RNAA, (d) INAA

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